Safety Evaluation With Open Items for the Bell Bend Nuclear Power Plant

Chapter 10, "Steam and Power Conversion System"

CONTENTS

LIST OF FIGURES

No figures were included in this report.

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10 STEAM AND POWER CONVERSION SYSTEM

10.1 Introduction

This chapter describes the staff's evaluation of the Bell Bend Nuclear Power Plant (BBNPP) steam and power conversion system. This chapter includes staff evaluations of the turbine-generator, and the main steam and feedwater systems including the main condenser and its associated supporting systems.

10.1.1 Summary of Application

BBNPP Combine Licensed (COL) BBNPP Final Safety Analysis Report (FSAR) Chapter 10 incorporates U.S. EPR FSAR Tier 2, Chapter 10 by reference with supplements as identified in the following sections. The staff's Safety Evaluation Report (SER) related to the U.S. EPR FSAR is not complete. The staff will update this chapter of the BBNPP SER to reflect the final disposition of the U.S. EPR SER. **Accordingly, RAI 91, Question 01-3 is being tracked as an open item for this purpose**.

Inspections, Tests, Analyses and Acceptance Criteria

The staff reviewed BBNPP COL application Part 10, "Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) and ITAAC Closure." For BBNPP COL application Part 10, Appendix B, Section 2.4, "Site-Specific ITAAC," the staff notes that there were no ITAAC within the scope of Chapter 10 of this report.

10.2 Turbine-Generator

This section of the report describes the turbine-generator (TG) for BBNPP. The TG converts the thermal energy supplied by the main steam supply system (MSSS) into electrical energy.

10.2.1 Summary of Application

In BBNPP COL FSAR Section 10.2, the BBNPP COL applicant provided the supplemental information for the items listed below.

U.S. EPR COL Information Items

- U.S. EPR COL Information Item 10.2-2

  A COL applicant that references the U.S. EPR design certification will provide applicable material properties of the site-specific turbine rotor, including the method of calculating the fracture toughness properties.

- U.S. EPR COL Information Item 10.2-3

  A COL applicant that references the U.S. EPR design certification will provide applicable site-specific turbine disk rotor specimen test data, load-displacement data from the compact tension specimens and fracture toughness properties.

- U.S. EPR COL Information Item 10.2-5

A COL applicant that references the U.S. EPR design certification will provide the site-specific turbine rotor inservice inspection program and inspection interval consistent with the manufacturer's turbine missile analysis.

- U.S. EPR COL Information Item 10.2-6

  A COL applicant that references the U.S. EPR design certification will include ultrasonic examination of the turbine rotor welds or provide an analysis which demonstrates that defects in the root of the rotor welds will not grow to critical size for the life of the rotor.

- U.S. EPR COL Information Item 10.2-7

  A COL applicant that references the U.S. EPR design certification will provide the site-specific inservice inspection program, inspection intervals, and exercise intervals consistent with the turbine manufacturer's recommendations for the main steam stop and control valves, the reheat stop and intercept valves, and the extraction non-return valves.

- U.S. EPR COL Information Item 10.2-8

  A COL applicant that references the U.S. EPR design certification will provide a reliability evaluation of the overspeed protection system, which includes the inspection, testing, and maintenance requirements needed to demonstrate reliable performance of the system.

10.2.2 Regulatory Basis

The regulatory basis of the information incorporated by reference with no departures is addressed within the Safety Evaluation Report (SER) related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for turbine rotor integrity, and the associated acceptance criteria are specified in NUREG-0800, Section 10.2.3, "Turbine Rotor Integrity."

The applicable regulatory requirements for turbine rotor integrity are as follows:

- GDC 4, which requires in part that structures, systems, and components important to safety shall be protected against environmental and dynamic effects, including the effects, including the effects of missiles that may result from equipment failure.

The related acceptance criteria are as follows:

- Regulatory Guide (RG) 1.115, "Protection Against Low-Trajectory Turbine Missiles," as it relates to turbine missile protection.

10.2.3 Technical Evaluation

The staff reviewed BBNPP COL FSAR Section 10.2 and reviewed the U.S. EPR FSAR (the design certification reference design) to ensure that the combination of the information in the reference design and the BBNPP COL application represents the complete scope of information relating to this review topic. The staff confirmed that the information contained in the BBNPP

COL application and incorporated by reference addresses the required information relating to the turbine rotor materials, maintenance and inspection. The results of the staff's evaluation of the information incorporated by reference in the BBNPP COL application are documented in the U.S. EPR SER, Chapter 10.

To ensure that the staff's findings on standard content that were documented in the SER for the reference COL application (Calvert Cliffs Nuclear Power Plant Unit 3[CCNPP3]) were equally applicable to the BBNPP COL application, the staff undertook the following reviews.

- The staff compared the BBNPP COL FSAR, to the CCNPP3 COL FSAR. In performing this comparison, the staff considered changes made to the BBNPP COL FSAR (and other parts of the COL application, as applicable) resulting from BBNPP COL applicant responses to staff requests for additional information (RAIs).

- The staff confirmed that all BBNPP COL applicant responses to staff RAIs identified in the corresponding standard content evaluation were endorsed by the BBNPP COL applicant.

- The staff verified that the site-specific differences were not relevant.

The staff completed its review and finds the standard content directly applicable to the BBNPP COL application.

U.S. EPR COL Information Items

- U.S. EPR COL Information Items 10.2-2

  A COL applicant that references the U.S. EPR design certification will provide applicable material properties of the site-specific turbine rotor, including the method of calculating the fracture toughness properties.

In BBNPP COL FSAR Section 10.2.3, the BBNPP COL applicant addressed this item as follows:

> {PPL Bell Bend, LLC} shall submit to the NRC the applicable material properties of the site-specific turbine rotor, including the method of calculating the fracture toughness properties.

- U.S. EPR COL Information Items 10.2-3

  A COL applicant that references the U.S. EPR design certification will provide applicable site-specific turbine disk rotor specimen test data, load-displacement data from the compact tension specimens and fracture toughness properties.

In BBNPP COL FSAR Section 10.2.3, the BBNPP COL applicant addressed this item as follows:

> {PPL Bell Bend, LLC} shall submit to the [U.S. Nuclear Regulatory Commission] NRC the applicable site-specific turbine disk rotor specimen test data, load-displacement data from the compact tension specimens and the fracture toughness properties to demonstrate that the associated information and data presented in the U.S. EPR FSAR is bounding.

The following portion of this technical evaluation section is reproduced from CCNPP3 COL SER Section 10.2.4 (the COL reference application) addressing COL Information Items 10.2-2 and 10.2-3.

> The staff reviewed [U.S. EPR] COL Information Item No. 10.2-2 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under FSAR Section 10.2.3.1, related to the material properties of the site-specific turbine rotor. The COL applicant addressed this issue by stating that following procurement of the CCNPP Unit 3 turbine generator, the COL holder will submit to the NRC the applicable material properties of the turbine rotor. In addition, the COL applicant addressed [U.S. EPR] COL Information Item No. 10.2-3, under COL FSAR Section 10.2.3.2, in that the COL holder would provide the applicable turbine disk rotor specimen test data, load-displacement data from the compact tension specimens, and the fracture toughness properties after the site-specific turbine is procured to demonstrate that the associated information and data presented in the COL FSAR are bounding.
>
> For the staff to conclude that the turbine-rotor material properties are bounded by the COL FSAR and the applicable turbine missile analysis, in RAI 69, Question 10.02.03-1, the staff requested that the COL applicant discuss whether COL Information Item No. 10.2-2 should be addressed in an inspection, test, analysis, and acceptance criterion (ITAAC) in the U.S. EPR design certification, or in the COL application, and discuss the completeness of the bounding analysis of the turbine rotor integrity. In a March 24, 2009, response to RAI 69, Question 10.02.03-1, the COL applicant stated that proposed license conditions for each of the COL information items, including COL Information Item Nos. 10.2-2 and 10.2-3, are provided in the COL application, Part 10, "ITAAC," Appendix A, "Proposed Combined License Conditions," Chapter 2, "COL information items." In addition, in a March 2, 2009, response to RAI 29, Questions 03.05.01-1 and 03.05.01-2, the COL applicant submitted the bounding turbine missile probability analysis, Alstom Report TSDMF 07-018 D, "ALSTOM Turbine Missile Analysis," dated May 30, 2007, for the Alstom turbine generator to be used in the U.S. EPR design at CCNPP Unit 3. The staff's review of this turbine missile probability analysis is discussed in Section 3.5.1.3 of this report. The staff determines this is an acceptable approach to ensuring that the as-built turbine rotor material properties will meet the criteria in SRP Section 10.2.3 based on the following:
>
> > The proposed license condition ensures that the COL holder submits the applicable turbine rotor material properties to confirm that the applicable as-built material properties of the turbine rotors will be within the limits of the FSAR information. The as-built material properties are not available until after procurement and fabrication of the turbine generator. Therefore, it is acceptable that the COL holder, after procurement of the turbine generator, provides an analysis using the as-built material properties to confirm it meets the manufacturer's requirements and the bounding turbine missile analysis Alstom Report TSDMF 07-018 D.

In addition, Appendix B to Part 10 of the CCNPP Unit 3 COL FSAR incorporates by reference the information in U.S. EPR FSAR Tier 1, Table 2.8.1-3, "Turbine Generator System ITAAC." Included in this table are ITAAC Commitments 1.0a and 1.0b. ITAAC Commitment 1.0a states that an analysis will be performed to ensure the as-built rotor material properties still meet the requirements of the manufacturer's turbine missile probability analysis. ITAAC Commitment 1.0b ensures that a turbine missile probability analysis will be performed for the as-built turbine design, and the probability of a turbine missile will be less than 10^{-4}. Therefore, the probability of turbine material and overspeed-related failures resulting in turbine missiles will be less than 1×10^{-4}, which meets the guidance in RG 1.115.

Minor wording changes were made to U.S. EPR COL Information Items 10.2-2 and 10.2-3 in response to U.S. EPR Request for Additional Information (RAI) 547 which stated, in part, "…Following the issuance of RAI 533, Question 3.6.1-13, it was identified by the staff that there are a number of similar [COL Information Items] COL I/Is in FSAR Tier 2 Table 1.8-2 that cannot theoretically be completed by the COL applicant prior to issuance of a COL license."

For BBNPP, the COL applicant has incorporated information in the BBNPP COL FSAR comparable to that of the reference CCNPP3 COL FSAR. Specifically, the proposed license conditions related to COL Information Items 10.2-2 and 10.2-3, incorporated in BBNPP Combined License Application (COLA) Part 10, Appendix A, ensure that the COL holder submits the applicable turbine rotor material properties to confirm that the applicable as-built material properties of the turbine rotors will be within the limits of the BBNPP COL FSAR information. The as-built material properties are not available until after procurement and fabrication of the turbine generator. Therefore, the staff finds acceptable that the COL holder, after procurement of the turbine generator, provides an analysis using the as-built material properties to confirm it meets the manufacturer's requirements and the bounding turbine missile analysis Alstom Report TSDMF 07-018 D. In addition to COLA Part 10, Appendix B incorporates by reference the information in U.S. EPR FSAR Tier 1, Table 2.8.1-3, "Turbine Generator System ITAAC." Included in this table are ITAAC Commitments 1.0a and 1.0b. ITAAC Commitment 1.0a states that an analysis will be performed to ensure the as-built rotor material properties still meet the requirements of the manufacturer's turbine missile probability analysis. ITAAC Commitment 1.0b ensures that a turbine missile probability analysis will be performed for the as-built turbine design, and the probability of a turbine missile will be less than 10^{-4}.

Therefore, the probability of turbine material and overspeed-related failures resulting in turbine missiles will be less than 1×10^{-4}, which meets the guidance in RG 1.115. Based upon the above, the staff concludes that the BBNPP COL applicant has acceptably addressed COL Information Items 10.2-2 and 10.2-3.

- U.S. EPR COL Information Item 10.2.5

  A COL applicant that references the U.S. EPR design certification will provide the site specific turbine rotor inservice inspection program and inspection interval consistent with the manufacturer's turbine missile analysis.

In BBNPP COL FSAR Section 10.2.3.6, the BBNPP COL applicant addressed this item as follows:

> The turbine manufacturer recommends major rotor inspection intervals of 10 years, during major overhauls. The inspections are performed during refueling outages on an interval consistent with the inservice inspection schedules in [American Society of Mechanical Engineers] ASME Section XI so that a total inspection has been completed at least once within a 10 year time period.

The following portion of this technical evaluation section is reproduced from CCNPP3 SER Section 10.2:

> The staff reviewed COL Information Item No. 10.2-5 from U.S. EPR FSAR Tier 2, Table 1.8-2 included under COL FSAR, Section 10.2.3.6, related to providing a site-specific turbine rotor inservice inspection interval which is consistent with the manufacturer's turbine missile analysis. In a March 2, 2009, response to RAI 29, Question 03.05.01-2, the COL applicant addressed this issue by stating that COL FSAR Section 10.2.3.6 would include an inspection interval of 10 years for the turbine rotor. U.S. EPR FSAR Tier 2, Section 10.2.3.6, Revision 1"Turbine Rotor Inservice Inspection Program Plan," added that the inspections of the turbine rotors will be performed during intervals consistent with the inservice inspection schedules in American Society of Mechanical Engineers (ASME) Code, Section XI so that a total inspection of the turbine rotor will be completed at least once within a 10-year period. The staff notes that the inservice inspection interval of 10 years is within the bounding turbine missile analysis per Alstom Report TSDMF 07-018 D. However, the staff is still reviewing issues related to the turbine missile analysis as discussed in Section 3.5.1.3 of this report. Therefore, upon satisfactory review and resolution of any open items for the turbine missile probability analysis, the staff determines a 10-year inservice inspection interval is acceptable and is consistent with the manufacturer's turbine missile analysis, and is therefore acceptable.
>
> However, the staff notes that SRP Section 10.2.3 states that the inservice inspection program should detect flaws that might lead to turbine rotor failure and should comply with the manufacturer's recommendations to provide assurance against turbine rotor failure. In a March 24, 2009, response to RAI 69, Question 10.02.03-2, the COL applicant stated that the COL FSAR incorporates U.S. EPR FSAR Tier 2, Section 10.2.3.6 by reference, with no departures or supplements. Therefore, the inspections will be performed based on the U.S. EPR inservice inspection plan. However, the staff notes that there are open items (reference RAI 100, Questions 10.02.03-9a and 9b) for the inservice inspection plan in U.S. EPR FSAR. Therefore, the CCNPP Unit 3 turbine rotor inservice inspection program is dependent on the satisfactory resolution of the aforementioned open items. The staff will update this report to reflect the final disposition of open items (reference RAI 100, Questions 10.02.03-9a and 9b). **RAI 100, Questions 10.02.03-9a and 9b are being tracked as confirmatory items.**

BBNPP COL FSAR Section 10.2.5 also references Alstom Report TSDMF 07-018 D, and similarly concludes that the inservice inspection interval of 10 years using the U.S. EPR FSAR

turbine rotor inservice inspection plan is bounded by the turbine missile analysis. Upon satisfactory review and resolution of any open items for the turbine missile probability analysis, the staff will make conclusions regarding the BBNPP turbine rotor inservice inspection plan.

- U.S. EPR COL Information Item 10.2-6

  A COL applicant that references the U.S. EPR design certification will include ultrasonic examination of the turbine rotor welds or provide an analysis which demonstrates that defects in the root of the rotor welds will not grow to critical size for the life of the rotor.

In BBNPP COL FSAR Section 10.2.3.6, the BBNPP COL applicant addressed this item as follows:

> The turbine manufacturer shall perform a preservice 100% volumetric examination of all turbine welds during manufacturing to verify the turbine rotor welds are free from any unacceptable defects. The turbine rotor manufacturer shall provide, within the Turbine Missile Analysis, specific analysis demonstrating that any crack assumed to start at t=0 (the beginning of the period between two inservice inspections), whether initiated on an exterior face or the internal faces of the internal and external disc fingers, will propagate to the surface of the rotor and will not reach critical size before the next inservice inspection. Such defects shall be detected via visual examination or selected surface examinations of the turbine rotor during the inservice inspection. The Turbine Rotor Inservice Inspection Program Plan will include a requirement to perform a visual inspection or selected surface examinations of the turbine rotor during the inservice inspection. And, in the event a surface defect is detected, to either perform an ultrasonic examination of the turbine rotor welds or have the turbine manufacturer provide an analysis which demonstrates that defects in the root of the rotor welds will not grow to critical size for the life of the rotor.

U.S. EPR COL Information Item 10.2-6 will be evaluated for the BBNPP COL application following the staff's evaluation of this item in the reference CCNPP3 SE for Chapter 10.

- U.S. EPR COL Information Item 10.2-7

  A COL applicant that references the U.S. EPR design certification will provide the site specific inservice inspection program, inspection intervals, and exercise intervals consistent with the turbine manufacturer's recommendations for the main steam stop and control valves, the reheat stop and intercept valves, and the extraction non-return valves.

In BBNPP COL FSAR Section 10.2.2.12, the BBNPP COL applicant addressed this item as follows:

> The inservice inspection program will include the inspection intervals and exercise intervals consistent with the turbine manufacturer's recommendations for the main steam stop and control valves, the reheat stop and intercept valves, and the extraction nonreturn valves. Table 13.4-2 provides the inservice inspection implementation milestone.

U.S. EPR COL Information Item 10.2-7 will be evaluated for the BBNPP COL application following the staff's evaluation of this item in the reference CCNPP3 SE for Chapter 10.

- U.S. EPR COL Information Item 10.2-8

  A COL applicant that references the U.S. EPR design certification will provide a reliability evaluation of the overspeed protection system, which includes the inspection, testing, and maintenance requirements needed to demonstrate reliable performance of the system.

In BBNPP COL FSAR Section 10.2.2.9, the BBNPP COL applicant addressed this item as follows:

> The overspeed protection system evaluation for the turbine generator, in terms of architecture and probability of failure on demand, is included in Alstom Document 75RC10001, Steam Turbine Protection System Overspeed Reliability Evaluation (Alstom, 2010). Based on the inspections and tests of the overspeed protection system defined in Chapter 4.2 of Alstom Report TSDMF 07-018 D (Alstom, 2007), the overall failure rate of the overspeed protection system is approximately 1.14E-9. In addition, plant procedures will control the inspection, testing and maintenance requirements for the turbine, including the requirements for the turbine overspeed protection system.

U.S. COL Information Item 10.2-8 will be evaluated for the BBNPP COL application following its evaluation in the reference CCNPP3 COL SE Chapter 10.

10.2.4 Post Combined License Activities

U.S. EPR FSAR Tier 2, Table 1.8-2 contains COL information items that the COL applicant is required to address. The following COL information items in Table 10.2.4-1 below includes the proposed combined license activities which the staff evaluated in this report, but that will be completed following issuance of the license as discussed in the SE section listed below and are listed as proposed license conditions in BBNPP COL, Part 10 Appendix A.

Table 10.2.4-1 Post Combined License Information Items

Item No.	Description	COL FSAR Section	COL SER Section
10.2-2	{PPL Bell Bend, LLC} turbine generator, {PPL Bell Bend, LLC} shall submit to the NRC the applicable material properties of the site-specific turbine rotor, including the method of calculating the fracture toughness properties.	[License Condition in BBNPP COL Part 10 Appendix A]	10.2.3
10.2-3	PPL Bell Bend, LLC} shall submit to the NRC the applicable site-specific turbine disk rotor specimen test data, load-displacement data from the compact tension specimens and the fracture toughness properties to demonstrate that	[License Condition in Part 10, Appendix A of the BBNPP	10.2.3

Item No.	Description	COL FSAR Section	COL SER Section
	the associated information and data presented in the U.S. EPR FSAR is bounding.	application]	
10.2-6	{PPL Bend, LLC} will include ultrasonic examination of the turbine rotor welds or provide an analysis which demonstrates that defects in the root of the rotor welds will not grow to critical size for the life of the rotor prior to fuel load.	[License Condition in Part 10, Appendix A of the BBNPP application	10.2.3
10.2-7	Prior to initial fuel load, plant procedures will control the inspection, testing and maintenance requirements for the turbine, including the requirements for the turbine overspeed protection system based on the inspections and tests defined in Chapter 4.2 of Alstom Report TSDMF 07-018 D.	[License Condition in Part 10, Appendix A of the BBNPP application]	10.2.3
10.2-8	Prior to initial fuel load, the inservice inspection program will include the inspection intervals and exercise intervals consistent with the turbine manufacturer's recommendations for the main steam stop and control valves, the reheat stop and intercept valves, and the extraction nonreturn valves	[License Condition in BBNPP COL application Part 10, Appendix A]	10.2.3

The staff continues to review BBNPP's proposed license conditions. The staff will address whether these license conditions are appropriate for inclusion in the BBNPP COL and the proper wording of the conditions in the staff's BBNPP COL Final Safety Evaluation Report. **Accordingly, final wording of license conditions for the BBNPP COL is being tracked as an Open Item.**

10.2.5 Conclusion

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the turbine generator incorporated by reference in the BBNPP COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR. The SER on the U.S. EPR is not yet complete**.** The staff will update this report to reflect the final disposition of the design certification application.

In addition, the staff concludes that the BBNPP COL applicant adequately addressed COL Information Items 10.2-2 and 10.2-3 by including these items as part of a proposed license condition in BBNPP COL application Part 10, Appendix A, requiring the COL holder to provide the turbine materials properties after the site-specific turbine has been procured in order to support the material property assumptions in the turbine rotor analysis.

The staff further concludes, contingent upon satisfactory review and resolution of any open items for the turbine missile probability analysis discussed in Section 3.5.1.3 of this report, that the BBNPP COL applicant adequately addressed COL Information Item 10.2-5 in the BBNPP COL FSAR and is, thus, acceptable because the inservice inspection interval conforms to guidance in SRP Section 10.2.3 and the turbine missile probability analysis.

Therefore, the staff concludes that the BBNPP COL applicant has described methods for ensuring the integrity of low-pressure turbine rotors by the use of suitable material with adequate fracture toughness of a conservative design and appropriate inservice inspections which provides reasonable assurance that the probability of failure with missile generation is low during normal operation, including transients up to design overspeed. Furthermore, the staff concludes that these methods ensuring the integrity of low-pressure turbine rotors satisfy the requirements of GDC 4, "Environmental and dynamic effects design bases," with respect to the protection of SCCs important to safety from the effects of turbine missiles

The staff further concludes, contingent upon satisfactory review and resolution of any open items for the turbine missile probability analysis discussed in Section 3.5.1.3 of this report, that the BBNPP COL applicant adequately addressed COL Information Item 10.2-5 in the BBNPP COL FSAR and is, therefore, acceptable because the inservice inspection interval conforms to guidance in SRP Section 10.2.3 and the turbine missile probability analysis.

With regard to U.S. EPR COL Information Items 10.2-6,7 and 8, evaluation of these items is deferred until they are addressed in the reference U.S. EPR design certification application.

10.3 Main Steam Supply System

This section describes the staff's review of the BBNPP main steam supply system and its associated design basis. In addition, details of the secondary water chemistry program and the flow accelerated corrosion (FAC) programs are presented.

10.3.1 Summary of Application

In BBNPP COL FSAR Section 10.3, the BBNPP COL applicant provided the supplemental information for the following:

U.S. EPR COL Information Items

- U.S. EPR COL Information Item 10.3-1

  A COL applicant that references the U.S. EPR design certification will identify the authority responsible for implementation and management of the secondary side water chemistry program.

- U.S. EPR COL Information Item 10.3-2

  A COL applicant that references the U.S. EPR design certification will describe essential elements of a FAC condition monitoring program that is consistent with Generic Letter 89-08 and NSAC-202L-R3 for the carbon steel portions of the steam and power conversion systems that contain water or wet steam.

10.3.2 Regulatory Basis

The regulatory basis of the information incorporated by reference is addressed within the FSER related to the U.S. EPR SER FSAR.

In addition, the relevant requirements of NRC regulation for the secondary side water chemistry and flow accelerated corrosion programs, and the associated acceptance criteria, are specified in NURE0800, Section 10.3.5, “Steam and Feedwater System Materials.” The applicable regulatory requirements for the secondary side water chjemistry and flow accelerated corrosion programs are as follows:

- The regulatory basis for accepting the Col information addressing the FAC program is provided in 10 CFR 50.55a, “Codes and Standards,” as it pertains to maintaining the requirements of the ASME Code, Section III for piping minimum wall thickness.

The related acceptance criteria are as follows:

- NSAC-202L-R3 and GL 89-08, “Erosion/Corrosion-Induced Pipe Wall Thinning,” as they relate to establishing an erosion-corrosion monitoring program.

10.3.3 Technical Evaluation

The staff reviewed BBNPP COL FSAR Section 10.3 and checked the design certification FSAR to ensure that the combination of the reference design and the BBNPP COL application represents the complete scope of information relating to this review topic. The staff confirmed that the information contained in the BBNPP COL application and incorporated by reference addresses the required information relating to the integrity of the reactor coolant pressure boundary. The results of the staff’s evaluation of the information incorporated by reference in the BBNPP COL application are documented in U.S. EPR SER Chapter 10.

To ensure that the staff’s findings on standard content that were documented in the SER for the reference CCNPP3 COL application that were equally applicable to the BBNPP COL application, the staff undertook the following reviews.

- The staff compared the BBNPP COL FSAR, to the CCNPP3 COL FSAR. In performing this comparison, the staff considered changes made to the BBNPP COL FSAR (and other parts of the COL application, as applicable) resulting from the BBNPP COL applicant responses to staff RAIs.

- The staff confirmed that all BBNPP COL applicant responses to RAIs identified in the corresponding standard content evaluation were endorsed.

- The staff verified that the site-specific differences were not relevant.

The staff completed its review and finds the evaluation performed for the standard content directly applicable to the BBNPP COL application.

U.S. EPR COL Information Items

- U.S. EPR COL Information Item 10.3-1

  A COL applicant that references the U.S. EPR design certification will identify the authority responsible for implementation and management of the secondary side water chemistry program.

In BBNPP COL FSAR Section 10.3.5, the BBNPP COL applicant addressed this item as follows:

> {PPL Bell Bend, LLC} shall implement the secondary side water chemistry program described in Section 10.3.5 of the U.S. EPR FSAR. The {Radiation Protection and Chemistry Manager} is the authority responsible for implementation and management of the secondary side water chemistry program.

The following portion of this technical evaluation section is reproduced from CCNPP3 SER Section 10.3:

> The COL applicant addresses COL Information Item No. 10.3-1 in COL FSAR Section 10.3.5. The COL applicant committed to the secondary water chemistry program as described in the U.S. EPR FSAR Tier 2, Section 10.3.5, "Secondary Water Chemistry Program," and stated that the Radiation Protection and Chemistry Manager is the authority responsible for implementation and management of the secondary water chemistry program. The staff finds that this is acceptable, because it follows the Electrical Power Research Institute (EPRI) [Pressurized Water Reactor] PWR Secondary Water Chemistry Guidelines Revision 6 (EPRI Report 1008224).

Based on the staff's review of the BBNPP COL applicant's proposed criteria and design bases for the condensate polishing system and the criteria for operation of the system, as set forth above, the staff concludes that the design of the condensate polishing system and supporting systems is acceptable to control secondary side water chemistry and does not adversely affect the integrity of the steam generator tubes and, therefore, meets the applicable reactor coolant pressure boundary integrity requirements of 10 CFR Part 50, GDC 14, as discussed in Section 5.4.2 of this report. This conclusion is based on the BBNPP COL applicant having met the recommendations of the latest version of the EPRI PWR Secondary Water Chemistry Guidelines, with respect to maintaining acceptable secondary chemistry control during normal operation and anticipated operational occurrences by reducing corrosion of steam generator tubes and materials, thereby reducing the likelihood and magnitude of reactor coolant pressure boundary piping failures and minimizing the occurrence of primary-to-secondary leakage. The staff considers this issue resolved.

The staff finds that the BBNPP COL applicant's commitment to designate the Radiation Protection and Chemistry Manager as the authority responsible for implementation and management of the secondary side water chemistry program acceptable since it satisfies the requirements of 10 CFR Part 50, Appendix B, Part I, "Organization," in that, "The authority and duties of persons and organizations performing activities affecting the safety-related functions of structures, systems, and components shall be clearly established and delineated in writing. BBNPP COL FSAR Table 13.1-1, "[BBNPP] Position/Site Specific Position Cross Reference," identifies the Radiation Protection and Chemistry Manager and identifies, via reference to

ANSI/ANS Standard 3.1, 1993, “Selection, Qualification, and Training of Personnel for Nuclear Power Plants,” the specific authority, education, and experience requirements for the Radiation Protection and Chemistry Manager. The staff considers this issue resolved.

- U.S. EPR COL Information Items 10.3-2

  A COL applicant that references the U.S. EPR design certification will describe essential elements of a FAC [flow accelerated corrosion] condition monitoring program that is consistent with Generic Letter 89-08 and NSAC-202L-R3 for the carbon steel portions of the steam and power conversion systems that contain water or wet steam.

In BBNPP COL FSAR Section 10.3.6.3, the BBNPP COL applicant addressed this item as follows:

> {PPL Bell Bend, LLC} shall develop and implement a flow accelerated corrosion (FAC) program that provides a structured, logical approach to identifying locations in the steam and power conversion system that could be susceptible to degradation of pressure boundary thickness due to erosion/corrosion (EC) and flow conditions. The FAC Program will be consistent with requirements and recommendations of Generic Letter 89-08 ”Erosion/Corrosion-Induced Pipe Wall Thinning” (NRC, 1989) and NSAC-202L-R3 ”Recommendations for an Effective Flow Accelerated Corrosion Program” (EPRI, 2006).

Additional details of the FAC program were provided.

The following portion of this technical evaluation section is reproduced from CCNPP3 SER Section 10.3.4:

> The COL applicant addresses COL Information Item No. 10.3-2 in COL FSAR Section 10.3.6.3. The COL applicant states that it will implement a FAC program that provides a structured, logical approach to identifying locations in the steam and power conversion system that could be susceptible to degradation of pressure boundary thickness due to erosion/corrosion and flow conditions. In addition, the COL applicant states that the FAC program will be consistent with recommendations of GL 89-08 and NSAC-202L-R3.
>
> The COL applicant will use multiple criteria to evaluate possible degradation in the steam and power conversion system. These criteria include process fluid characteristics, process flow rates, flow path configuration, temperature, pressure, duty cycles or cycling conditions, pressure boundary mechanical stresses, and materials of construction. The criteria are evaluated during the design and construction phases using industry operation experience to identify locations that are susceptible to FAC. Adjustments are then made to pipe routing and component locations to minimize flow velocities and turbulence. The staff finds this acceptable, because the COL applicant will modify systems as necessary to minimize conditions that can promote FAC.
>
> The COL applicant’s FAC program includes preservice examinations, including thickness measurements, prior to plant operation. Preservice examinations are conducted using grid locations and measurement methods anticipated for the inservice examination. Preservice examinations will also be performed on

components containing greater than or equal to 0.10 percent chromium. The minimum level of chromium provides resistance to FAC. These components will be inspected at least once, after the plant goes into operation, to verify that they are not experiencing an appreciable amount of degradation. Grid locations are determined based on industry operation experience and a FAC modeling software program in accordance with GL 89-08 and NSAC-202L-R3. Examination results are recorded and trended throughout the life of the plant to determine required adjustments in location and frequency of subsequent examination in order to maintain minimum wall thickness, design margins of safety, and piping integrity. The staff finds that the supplemental information provided by the applicant, to address the FAC monitoring program, is acceptable, because the COL applicant's FAC program will meet requirements and recommendations of GL 89-08 and NSAC-202L-R3.

In an April 9, 2009, response to RAIs 74 and 76, the reference CCNPP3 COL applicant provided the details of the FAC program for CCNPP3 that were adopted by the BBNPP COL applicant in a July 19, 2010, letter to the NRC. Minor wording changes were made to U.S. EPR COL Information Item 10.3-2 in response to U.S. EPR RAI 547 which stated, in part, "…Following the issuance of RAI 533, Question 3.6.1-13, it was identified by the staff that there are a number of similar COL [Information Items] I/Is in FSAR Tier 2 Table 1.8-2 that cannot theoretically be completed by the COL applicant prior to issuance of a COL license." Wording changes were made to U.S. EPR COL Information Item 10.3-2 to require submittal of the "essential elements" of the FAC program prior to issuance of a COL. A license condition contained in BBNPP COL application Part 10, Appendix A, requires implementation of the FAC program; however, the BBNPP COL applicant removed the implementation schedule from the proposed license condition. The implementation schedule which was removed from proposed License Condition COL Information Item 10.3-2, "…prior to fuel loading" is acceptable and should be reinserted in the subject proposed license condition. **Revision of License Condition 10.3-2 is being tracked as an open item.**

10.3.4 Post Combined License Activities

U.S. EPR FSAR Tier 2, Table 1.8-2 contains COL information items that the COL applicant is required to address. The following COL information items in Table 10.2.5-1 below include the proposed combined license activities that the staff has evaluated in this report, but that will be completed following issuance of the license as discussed in the SER section listed below:

Table 10.3.4-1 Post Combined License Activities

Item No.	Description	COL FSAR Section	COL SER Section
10.3-2	{PPL Bell Bend, LLC} will develop and implement a FAC condition monitoring program that is consistent with Generic Letter 89-08 and NSAC-202L-R3 for the carbon steel portions of the steam and power conversion systems that contain water or wet steam.	[License Condition in BBNPP application Part 10, Appendix A]	10.3.3

The staff continues to review BBNPP's proposed license conditions. The staff will address whether these license conditions are appropriate for inclusion in the BBNPP COL and the proper wording of the conditions in the staff's Final Safety Evaluation Report. **Accordingly**, **final working of license conditions for the BBNPP COL is being tracked as an open item.**

10.3.5 Conclusion

The staff reviewed the BBNPP COL application and checked the reference design certification FSAR. The staff confirmed that the BBNPP COL applicant addressed the required information relating to the main steam supply system, and there is no outstanding information expected to be addressed in the BBNPP COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the main steam supply system incorporated by reference with no departures in the BBNPP COL FSAR have been documented in the staff's safety evaluation report on the design certification application for U.S. EPR FSAR Tier 2, Chapter 10.

The staff concludes that the BBNPP COL applicant has appropriately addressed U.S. EPR COL Information Item 10.3-1, because the secondary water chemistry program will follow the EPRI PWR Secondary Water Chemistry Guidelines Revision 6 (EPRI Report 1008224).

The staff concludes that that the BBNPP COL applicant has appropriately addressed U.S. EPR COL Information Item 10.3-2 since the proposed program conforms to industry practice to address the concerns related to FAC and to monitor the piping wall degradation caused by FAC during plant operation. The staff notes that establishment of a FAC monitoring program adequately addresses the concerns identified in GL 89-08, which includes the requirements of 10 CFR 50.55a, and is therefore acceptable.

The staff finds the implementation schedule that was removed from proposed License Condition COL Information Item 10.3-2, "…prior to fuel loading" acceptable and should be reinserted in the subject proposed license condition. **Revision of License Condition 10.3-2 is being tracked as an open item.**

The SER concerning the U.S. EPR FSAR is not yet complete. The staff will update Section 10.3 of this report to reflect the final disposition of the design certification application.

10.4 Other Features of Steam and Power Conversion System

This section describes the staff's review of the BBNPP systems associated with the steam and power conversion system. This section also provides a general description of the main condenser, evacuation system, turbine gland sealing system (TGSS), turbine by-pass system, circulating water system (CWS), condensate polishing system (CPS), condensate and feedwater system (CFS), steam generator blowdown system, and emergency feedwater system. The steam and power conversion system support systems for BBNPP are the same as the reference U.S. EPR steam and power conversion support systems. The major differences relate to the materials of construction and operating pressure of the main condenser and the features of the circulating water system. These changes are a function of the local source and water quality of cooling water at the BBNPP site.

BBNPP COL FSAR Section 10.4, "Other Features of Steam and Power Conversion System," incorporates, by reference, the U.S. EPR FSAR with supplemental information. Supplemental information is provided in BBNPP COL FSAR Sections 10.4.1, "Main Condensers," and 10.4.5, "Circulating Water System." U.S. EPR FSAR Tier 2, Sections 10.4.2, "Main Condenser Evacuation System (MCES)"; 10.4.3, "Turbine Gland Sealing System"; 10.4.4, "Turbine Bypass System (TBS)"; 10.4.6, "Condensate Polishing System"; 10.4.7, "Condensate and Feedwater System"; 10.4.8, "Steam Generator Blowdown System"; and 10.4.9, "Emergency Feedwater System," incorporate by reference with no departures or supplements. Supplemental information is provided in BBNPP COL FSAR Sections 10.4.1, "Main Condensers," and 10.4.5, "Circulating Water System," as follows:

10.4.1 Main Condensers

10.4.1.1 *Introduction*

The main condenser functions as the steam cycle heat sink, condensing steam from the main turbine or from the turbine bypass system (TBS). The BBNPP main condenser uses a multi-pressure, three-shell condenser unit, with each shell located beneath its respective low pressure (LP) turbine. The tubes in each shell are oriented transversely to the turbine generator longitudinal axis. Each shell contains two or more tube bundles and circulating water flows in series through the tubes inside the three single-pass shells. The hot-wells are partitioned and connected so that condensate cascades from the LP hot-well to the high pressure (HP) hot-well. The condensate pumps take suction from the HP hot-well.

10.4.1.2 *Summary of Application*

BBNPP COL FSAR Section 10.4.1 incorporates by reference U.S. EPR FSAR Tier 2, Section 10.4.1 "Main Condensers," with no departures or supplements.

Supplemental information was provided in BBNPP COL FSAR Section 10.4.1 to address U.S. EPR COL Items as listed in U.S EPR FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items":

- U.S. EPR COL Information Item 10.4-1

  A COL applicant that references the U.S. EPR design certification will describe the site-specific main condenser materials.

- U.S. EPR COL Information Item 10.4-2

  A COL applicant that references the U.S. EPR design certification will describe the site-specific design pressure and test pressure for the main condenser.

10.4.1.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within Chapter 10 of the SER related to the U.S. EPR FSAR.

In addition, the relevant requirements of NRC regulations for the main condensers, and the associated acceptance criteria, are specified in NUREG-0800, Section 10.4.1, "Main Condensers."

The applicable regulatory requirement for main condensers is as follows:

- GDC 60, "Control of Releases of Radioactive Materials to the Environment," as it relates to preventing excessive releases of radioactivity to the environment which may result from a failure of a structure, system or component in the main condenser.

10.4.1.4 *Technical Evaluation*

The staff reviewed BBNPP COL FSAR Section 10.4.1 and reviewed the reference design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the BBNPP COL FSAR represents the complete scope of required information relating to this review topic. The review confirmed that the information contained in the BBNPP COL application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 10.4.1 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the main condensers has been documented in the U.S. EPR SE for Chapter 10.

The staff's review of the information contained in the BBNPP COL FSAR is as follows:

U.S. EPR COL Information Items

- U.S. EPR COL Information Item 10.4-1

  A COL applicant that references the U.S. EPR design certification will describe the site-specific main condenser materials.

In BBNPP COL FSAR Section 10.4.1.2, "System Description," the BBNPP COL applicant provided information to address COL Information Item 10.4-1. BBNPP COL FSAR Section 10.4.1.2 states that the site-specific main condenser for BBNPP will be comprised of stainless steel tubes and stainless steel-clad tube sheet. The staff finds these materials acceptable, since stainless steel exhibits sufficient corrosion resistance considering conditions at the BBNPP site.

- U.S. EPR COL Information Item 10.4-2

  A COL applicant that references the U.S. EPR design certification will describe the site-specific design pressure and test pressure for the main condenser.

In BBNPP COL FSAR Section 10.4.1.2, the BBNPP COL applicant provided information to address COL Information Item 10.4-2. BBNPP COL FSAR Section 10.4.1.2 states that the site-specific design pressure and test pressure for the BBNPP main condenser are 690 kPa-gauge (100 psig) and 1034 kPa-gauge (150 psig), respectively.

The staff finds that the BBNPP COL applicant adequately addressed COL Information Item 10.4-2 by providing site-specific design and test pressures for the main condenser which are consistent with the U.S EPR FSAR, and are therefore acceptable.

10.4.1.5 *Post Combined License Information Items*

There are no post COL activities related to this section.

10.4.1.6 *Conclusion*

The staff reviewed the application and checked the reference design certification FSAR. The staff's review confirmed that the BBNPP COL applicant addressed the required information relating to the main condensers, and there is no outstanding information expected to be addressed in the BBNPP COL FSAR related to this section.

The staff reviewed the information in the U.S. EPR FSAR on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the main condensers incorporated by reference in the BBNPP COL FSAR have been documented in the staff's safety evaluation report on the design certification application for the U.S. EPR.

10.4.2 Main Condenser Evacuation System

The main condenser evacuation system removes air and non-condensable gases from the main condenser and connected steam side systems during plant startup, cooldown, and normal operation.

BBNPP COL FSAR Section 10.4.2, "Main Condenser Evacuation System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.2. The staff reviewed the BBNPP COL FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S EPR FSAR Tier 2, Section 10.4.2 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the main condenser evacuation system incorporated by reference with no departures in the BBNPP COL FSAR have been documented in the staff's SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.2 of this report to reflect the final disposition of the design certification application.

10.4.3 Turbine Gland Sealing System

The turbine gland sealing system prevents the escape of steam from the turbine shaft and casing penetrations and the glands of main steam stop and control valves. This system also prevents air leakage into the low pressure (LP) turbine glands.

BBNPP COL application, Section 10.4.3, "Turbine Gland Sealing System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.3. The staff reviewed the BBNPP COL FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.3 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the turbine gland sealing system incorporated by reference with no departures in the BBNPP COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.3 of this report to reflect the final disposition of the design certification application.

10.4.4 Turbine Bypass System

The turbine bypass system discharges main steam from the steam generators (SGs) directly to the main condenser in a controlled manner, bypassing the turbine. This process minimizes transient effects on the reactor coolant system (RCS) during plant startup, hot shutdown and cooldown; and step load reductions in generator load. The TBS is also referred to as the steam dump system.

BBNPP COL FSAR Section 10.4.4, "Turbine Bypass System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.4. The staff reviewed the BBNPP COL FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.4 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the turbine bypass system incorporated by reference with no departures in the BBNPP COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR. The SER on the U.S. EPR FSAR is not yet complete. The staff will update Section 10.4.4 of this report to reflect the final disposition of the design certification application.

10.4.5 Circulating Water System

10.4.5.1 *Introduction*

The BBNPP uses a circulating water system (CWS) to dissipate heat. At BBNPP, the CWS is a closed-loop system that supplies cooling water from the normal heat sink to the turbine condensers and auxiliary cooling water system (ACWS). The BBNPP CWS also utilizes two non-plume abdated natural draft cooling towers for heat dissipation.

10.4.5.2 *Summary of Application*

BBNPP COL FSAR Section 10.4.5, "Circulating Water System," incorporates by reference U.S. EPR FSAR Tier 2, Section 10.4.5, "Circulating Water System."

In addition, in BBNPP COL FSAR Sections 10.4.5.2, "System Description," 10.4.5.3, "Safety Evaluation," and 10.4.5.5, "Instrumentation Requirements," the BBNPP COL applicant provided the following supplemental information:

U.S. EPR Interface Requirements

The COL applicant provided site-specific design details for the CWS including makeup water, and water treatment to address Interface Item 10-1 in U.S. EPR FSAR Tier 2, Table 1.8-1, "Summary of U.S. EPR Plant Interfaces with Remainder of Plant."

U.S. EPR COL Information Items

The BBNPP COL applicant addressed COL Information Items 10.4-3, 10.4-4, 10.4-5, 10.4-6, and 10.4-7, described in U.S. EPR FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items."

- U.S. EPR COL Information Item 10.4-3

  A COL applicant that references the U.S. EPR design certification will provide the description of the site-specific portions of the CWS.

- U.S. EPR COL Information Item 10.4-4

  A COL applicant that references the U.S. EPR design certification will provide the specific chemicals used within the chemical treatment system as determined by the site-specific water conditions.

- U.S. EPR COL Information Item 10.4-5

  A COL applicant that references the U.S. EPR design certification will provide the site-specific CWS piping design pressure.

- U.S. EPR COL Information Item 10.4-6

  If a vacuum priming system is required, a COL applicant that references the U.S. EPR design certification will provide the site-specific information.

- U.S. EPR COL Information Item 10.4-7

  A COL applicant that references the U.S. EPR design certification will provide information to address the potential for flooding of safety related equipment due to failures of the site specific CWS.

Site-specific Information Replacing Conceptual Design Information

The BBNPP COL applicant provided additional information to replace conceptual design information contained in the U.S. EPR FSAR.

BBNPP COL FSAR Section 10.4.5.2.2 includes site-specific information to replace conceptual design information for the cooling towers, circulating water pumps, cooling tower makeup system, chemical treatment system, cooling tower blowdown system, and piping and valves. BBNPP COL FSAR Sections 10.4.5.3 and 10.4.5.5 include site-specific information to replace conceptual design information related to the safety evaluation and instrumentation requirements, respectively.

10.4.5.3 *Regulatory Basis*

The regulatory basis of the information incorporated by reference is addressed within the SER related to U.S. EPR FSAR Tier 2, Chapter 10.

In addition, the relevant requirements of NRC regulations for the circulating water system, and the associated acceptance criteria, are specified in NUREG-0800, Section 10.4.5, “Circulating Water System.”

The applicable regulatory requirements for the CWS are as follows:

1. GDC 2, “Design Bases for Protection Against Natural Phenomena,” as it relates to the failure of the non-safety-related system or component due to natural phenomena such

as earthquakes, tornadoes, hurricanes, and floods should not adversely affect the safety-related structures, systems and components.

2. GDC 4, "Environmental and Dynamic Effects Design Bases," as it relates to design provisions provided to accommodate the effects of discharging water that may result from a failure of a component or piping in the CWS.

10.4.5.4 *Technical Evaluation*

The staff reviewed BBNPP COL FSAR Section 10.4.5 and reviewed the reference design certification FSAR to ensure that the combination of the information in the U.S. EPR FSAR and the information in the BBNPP COL FSAR represents the complete scope of required information relating to this review topic. The staff's review confirmed that the information contained in the application and incorporated by reference addresses the required information relating to this section. U.S. EPR FSAR Tier 2, Section 10.4.5 has been reviewed by the staff under Docket No. 52-020. The staff's technical evaluation of the information incorporated by reference related to the circulating water system has been documented in the staff safety evaluation on the design certification application for the U.S. EPR.

The staff's review of the information contained in the FSAR is discussed as follows:

Interface Requirements

U.S. EPR FSAR Tier 2, Table 1.8-1, Interface Item 10-1 identifies a site interface requiring design details for the CWS, including makeup water and water treatment. These site-specific design details replace the conceptual design identified in the U.S. EPR FSAR. These site-specific design details are also addressed in the COL information items below.

U.S. EPR COL Information Items

The BBNPP COL applicant addressed the COL Information Items 10.4-3, 10.4-4, 10.4-5, 10.4-6, and 10.4-7, described in the U.S. EPR FSAR Tier 2, Table 1.8-2, "U.S. EPR Combined License Information Items."

- U.S. EPR COL Information Item 10.4-3

  A COL applicant that references the U.S. EPR design certification will provide the description of the site-specific portions of the CWS.

The BBNPP COL applicant provided site-specific supplemental information to address this COL information item as follows:

> The CWS at BBNPP is a closed-loop system. It uses two non-plume abated natural draft cooling towers that are approximately 475 ft. (145 m.) high and 350 ft. (107 m.) in diameter at the base. The CWS rejects to the atmosphere up to 1.0E+10 BTU/hr (2.52E+09 Kcal/hr) of waste heat from the main condensers and the closed cooling water system (CLCWS) during normal plant operation at full station load. The CWS has four 25 percent capacity constant speed, vertical shaft type circulating water pumps housed in the CWS Pumphouse adjacent to the cooling towers, and has a nominal flow rate of 720,000 gpm (2,725,496 lpm). The pumped water travels through the tube side of three series connected steam condensers, and then returns to the CWS cooling tower via the CWS return

piping. The cooling tower basin is sized to meet pump suction head requirements and to prevent formation of vortices at the pump suctions. The cooling tower basin level is controlled by a level control system. Also, there are two 100 percent capacity ACWS pumps that receive cooling water from the CWS and deliver the water to the CLCWS heat exchangers. Heat from the CLCWS is transferred to the ACWS and heated auxiliary cooling water is returned to the CWS downstream of the main condensers and then to the spray headers of the cooling tower. After passing through the cooling tower, the cooled water is recirculated back to the circulating water pump building to complete the closed cycle cooling water loop.

The tower design specifications are shown in BBNPP COL FSAR Table 10.4-1. The cooling tower has a blowdown system to maintain the concentration of dissolved solids in the CWS within the acceptable limits. Makeup water is required to replace the losses from evaporation, blowdown, and drift. Peak expected evaporative losses, blowdown, and maximum drift losses are depicted in Table 10.4.1. Approximately 23,808 gpm (90,123 lpm) of makeup water is taken from the Susquehanna River using three 50% capacity vertical makeup pumps housed in the CWS makeup water intake structure. To prevent debris from passing into the circulating water system, there is a dual-flow traveling screen and a screen wash pump in each of the three bays that remove debris prior to entering the makeup water pumps' suction bells. The intake structure also utilizes a trash rake. The CWS makeup system is shown in BBNPP COL FSAR Figure 10.4-6. The CWS makeup water intake structure is shown in BBNPP COL FSAR Figures 10.4-5 and 10.4-7, "BBNP Intake Structure (Section View)."

There is a Combined Waste Water Retention Pond to provide time for settling of suspended solids from the blowdown water, and to permit further chemical treatment of the wastewater, if required. The retention pond serves as a collection point for the cooling tower blowdown, essential service water system (ESWS) cooling tower blowdown, and other plant discharges prior to their discharge in the Susquehanna River. Discharge is routed through the CWS makeup and Raw Water Supply System (RWSS) intake pipe routing to the discharge diffuser, prior to entering the river. The Combined Waste Water Retention pond discharge flow path is shown in BBNPP COL FSAR Figure 10.4-8, "Circulating Water System P&ID (Blowdown System)." The discharge diffuser is shown in BBNPP COL FSAR Figure 10.4-9, "Discharge Diffuser."

The Combined Waste Water Retention Pond discharge consists of a discharge header, the discharge diffuser, valves, and associated instrumentation and controls for the control and monitoring of discharge flow into the Susquehanna River. The discharge piping is routed to the discharge diffuser at approximately 476 ft (145m) elevation in the river. Exit velocity for the discharge flow has been evaluated by the applicant to be adequate for thermal mixing purposes. Figure 10.4-8 shows the flow path of the discharge piping.

The staff reviewed the site-specific design information provided in the subsections of the BBNPP COL FSAR Section 10.4.5 and finds that the BBNPP COL applicant adequately addressed the final configuration of the CWS as specified in BBNPP COL Information

Item 10.4-3. The evaluation of the site-specific design against the regulatory criteria cited earlier is as follows:

Regarding compliance with GDC 2 criteria, based on the above description, the staff finds that the BBNPP CWS is a non-safety-related system and a non-seismically designed system, which is located in the Turbine Building. Failure of the CWS or its components due to natural phenomena will have no adverse affects on safety-related SSCs, since such components are not located in the Turbine Building. Therefore, the staff finds that the BBNPP CWS meets the requirements of GDC 2.

- U.S. EPR COL Information Item 10.4-4

  A COL applicant that references the U.S. EPR design certification will provide the specific chemicals used within the chemical treatment system as determined by the site-specific water conditions.

COL Information Item 10.4-4 instructs the COL applicant to provide the specific chemicals used within the chemical treatment system as determined by the site-specific water conditions. BBNPP COL FSAR Section 10.4.5.2.2, "Component Description," specifically identifies the treatment chemicals to be used for the circulating water. The BBNPP COL applicant names sodium hypochlorite as the biocide, sulfuric acid as the pH adjuster, acrylate copolymer as the deposit control agent and phosphonate as both an additional deposit control agent and corrosion inhibitor.

The staff finds that the BBNPP COL applicant has satisfied COL Information Item 10.4-4 because all the specific chemicals that will be inserted into the CWS have been identified and inserted to the CWS. Although there are no specific regulatory criteria for the CWS chemistry, NUREG-0800, Section 10.4.5 states that GDC 4 establishes design limits for the CWS that will minimize the potential for creating adverse environmental conditions (e.g., flooding of systems and components important to safety). Use of materials that are corrosion-resistant in the environment supports compliance with GDC 4 by minimizing the probability of catastrophic failures that could result in flooding. Therefore, the staff finds the applicant's response acceptable because the materials used are sufficiently resistant to corrosion.

- U.S. EPR COL Information Item 10.4-5

  A COL applicant that references the U.S. EPR design certification will provide the site-specific CWS piping design pressure.

COL Information Item 10.4-5 instructs a COL applicant that references the U.S. EPR design certification to provide the site-specific CWS piping design pressure. Under "Piping and Valves," in BBNPP COL FSAR Section 10.4.5.2.2, the BBNPP COL applicant stated that the piping design pressure is 100 psig (690 kPa-gauge). The staff finds that a piping design pressure of 100 psig (690 kPa-gauge) is typical for a power plant CWS. The staff also finds that the piping design pressure of the BBNPP CWS is consistent with the design pressures of the conceptual (non-site-specific) design of the U.S. EPR CWS, and is therefore acceptable

- U.S. EPR COL Information Item 10.4-6

  If a vacuum priming system is required, a COL applicant that references the U.S. EPR design certification will provide the site-specific information.

COL Information Item 10.4-6 instructs that if a vacuum priming system is required, a COL applicant that references the U.S. EPR design certification should provide the site-specific design information. In BBNPP COL FSAR Section 10.4.5.2.2, under "Vacuum Priming System," the BBNPP COL applicant stated that a vacuum priming system is not required at BBNPP; however, the BBNPP COL applicant did not provide any justification for its statement. Therefore, in RAI 95, Question 10.04.05-1, the staff requested that the BBNPP COL provide additional information and/or clarification in this regard.

In a March 29, 2011, response to RAI 95, Question 10.04.05-1, the BBNPP COL applicant provided details related to the addition of the vacuum priming system. The BBNPP COL applicant stated that the vacuum priming system is sized with two 50 percent capacity pumps and is controlled from the plant Distributed Control System (DCS). The vacuum priming system operates to ensure the main condenser water boxes are filled with water by removing air from the water boxes. The water level in the CWS is monitored by level instrumentation in the vacuum priming system. The BBNPP COL applicant proposed a revision of the BBNPP COL application to include this information. The staff reviewed the BBNPP COL applicant's response and finds that adequate details have been included to justify the addition of the vacuum priming system, and therefore finds the response acceptable. The staff notes that the BBNPP COL applicant has updated the BBNPP COL FSAR to include the supplemental information concerning the vacuum priming system.

- U.S. EPR COL Information Item 10.4-7

  A COL applicant that references the U.S. EPR design certification will provide information to address the potential for flooding of safety related equipment due to failures of the site specific CWS.

COL Information Item 10.4-7 instructs a COL applicant that references the U.S. EPR design certification to provide information to address the potential for flooding of safety related equipment due to failures of the site-specific CWS.

With respect to addressing COL Information item 10.4.-7 and the requirements of GDC 4 as it relates to internal flooding, the BBNPP COL applicant provided a site-specific discussion in BBNPP COL FSAR Section 10.4.5.3. The BBNPP COL applicant stated that internal flooding of the Turbine Building due to an unisolatable break or crack in a CWS pipe or failure of a CWS component, including expansion joints, does not result in damage to safety-related SSCs. The BBNPP COL applicant further stated that below the main steam piping penetrations, no direct pathway through which flooding could spread exists between the Turbine Building and adjacent structures that house safety-related SSCs, and that flooding would exit the Turbine Building. However, the BBNPP COL applicant did not provide a description of how flood water would exit the Turbine Building (i.e., blowout panels) before the water level would rise to flood through the main steam line penetrations. Therefore, in RAI 95, Question 10.04.05-2, the staff requested that the BBNPP COL applicant provide additional detail on specific designs features used to allow the flood water from a CWS system failure to exit the Turbine Building, including locations of these design features and the flowpath of the water after exiting the building to ensure that this water will not adversely affect safety-related structures and components.

In a March 12, 2012, response to RAI 95, Question 10.04.05-2, the BBNPP COL applicant discussed a flood analysis that had been performed to assess the effect of a flood resulting from a CWS pipe failure inside the Turbine Building and exiting to the yard area. The BBNPP COL applicant stated that water from a CWS pipe failure in the Turbine Building exits through hinged

relief panels provided on the east and south sides of the building. Flow exiting through relief panels on the south side of the building will flow primarily to the south. Flow exiting through relief panels on the east side will be diverted to the north and south by the transformer barrier walls located east of the Turbine Building. To prevent flood water from flowing west to the safety-related plant buildings, the finished grade between the Turbine Building and the ESW cooling tower will be raised locally to form a gently-sloping berm. The staff reviewed the BBNPP COL applicant's response to RAI 95, Question 10.04.05-2 and finds that the analysis performed by the BBNPP COL applicant demonstrates that flood water exiting the relief panels are directed to the north and south and does not pose a flooding risk to safety-related SSCs. Also, there is a raised berm that prevents CWS flood water from reaching safety related plant buildings west of the Turbine Building. The BBNPP COL applicant provided BBNPP COL FSAR markups reflecting this response. Accordingly, the staff finds the BBNPP COL applicant's response acceptable. The BBNPP COL applicant has updated the BBNPP COL FSAR to address the potential for flooding of safety-related equipment due to failures of the site-specific CWS.

10.4.5.5 *Post Combined License Information Items*

There are no post COL activities related to this section.

10.4.5.6 *Conclusions*

The staff concludes that the information pertaining to the BBNPP COL FSAR Section 10.4.5 is within the scope of the design certification and adequately incorporates by reference U.S. EPR FSAR Tier 2, Section 10.4.5.

The staff reviewed the CWS documented in BBNPP COL FSAR Section 10.4.5, and the BBNPP COL applicant's RAI responses as they relate to CWS flooding concerns. On the basis of this review, the staff finds that the BBNPP CWS continues to meet all acceptance criteria documented in the U.S. EPR SER, and is therefore acceptable. In addition, the staff concludes that the site-specific CWS design meets GDC 2 and GDC 4 since failure of the CWS or its components due to natural phenomena will have no adverse affects on safety-related SSCs and an internal unisolatable break or water exiting the Turbine Building does not result in damage to safety-related SSCs. Accordingly, the staff finds the BBNPP CWS design acceptable.

10.4.6 Condensate Polishing System

The condensate polishing system is part of the CWS and, as indicated in NUREG-0800, Section 10.4.6 the purpose of the CWS is to remove dissolved and suspended impurities resulting from corrosion caused by condenser or steam generator leaks that could be introduced into the CWS by carryover from the main steam system. The CWS is not necessary for safe-shutdown or mitigation of postulated accidents, but it is important in maintaining the secondary coolant quality in pressurized water reactors.

BBNPP COL FSAR Section 10.4.6, "Condensate Polishing System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.6, "Condensate Polishing System." The staff reviewed the BBNPP COL application and checked the reference design certification FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.6 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the condensate polishing system incorporated by reference in the BBNPP COL FSAR have been documented in the staff SER on the design certification application for the U.S. EPR.

10.4.7 Condensate and Feedwater System

The condensate and feedwater system provides feedwater to the steam generators at the required temperature, pressure, and flow rate. Condensate is pumped from the main condenser hotwell by the condensate pumps, passes through the low pressure feedwater heaters and the deaerator-feedwater storage tank to the main feedwater (MFW) pumps, and is then pumped through the high pressure feedwater heaters to the steam generators (SGs). The CFS includes a number of stages of regenerative feedwater heating and provisions for maintaining feedwater quality. The CFS also includes extraction piping from the steam turbines and feedwater heater vents and drains, and drains from the moisture separator reheaters.

BBNPP COL FSAR Section 10.4.7, "Condensate and Feedwater System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.7, "Condensate and Feedwater System." The staff reviewed the BBNPP COL application and checked the referenced U.S. EPR FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.7 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the condensate and feedwater system incorporated by reference in the BBNPP COL FSAR have been documented in the staff's SER on the design certification application for the U.S. EPR.

10.4.8 Steam Generator Blowdown System (PWR)

The steam generator blowdown system assists in maintaining the chemical characteristics of the secondary water. The SGBS provides the capability for continuous hot blowdown of the secondary side of the steam generators. The SGBS includes equipment for heat recovery, purification, and reuse of SG blowdown.

BBNPP COL FSAR Section 10.4.8, "Steam Generator Blowdown System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.8, "Steam Generator Blowdown System."

The staff reviewed the BBNPP COL application and checked the reference design certification FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.8 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the steam generator blowdown system incorporated by reference in the BBNPP COL FSAR have been documented in the staff's SER on the design certification application for the U.S. EPR.

10.4.9 Emergency Feedwater System

The emergency Feedwater System supplies water to the steam generators to restore and maintain water level and to remove decay heat following the loss of normal feedwater during design basis transient and accident conditions. This removes heat from the reactor coolant system, which is first transferred to the secondary side via the SGs, then discharged as steam to the condenser or via the SG main steam relief valves (MSRVs).

BBNPP COL FSAR Section 10.4.9, "Emergency Feedwater System," incorporates by reference, with no departures or supplements, U.S. EPR FSAR Tier 2, Section 10.4.9, "Emergency Feedwater System." The staff reviewed the BBNPP COL application and checked the reference design certification FSAR to ensure that no issues relating to this section remained for review. The staff's review confirmed that there are no outstanding issues related to this section.

The staff reviewed the information in the U.S. EPR FSAR Tier 2, Section 10.4.9 on Docket No. 52-020. The results of the staff's technical evaluation of the information related to the emergency feedwater system incorporated by reference in the BBNPP COL FSAR have been documented in the staff's SER on the design certification application for the U.S. EPR.